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ABSTRACT

A study consisting of two experiments attempted to further adapt the visual preference procedure for determining children's meaningful phonological perception. In the first experiment, 1-year-olds were presented with auditory stimuli (words) and screens containing paired color photographs of the object described by each word and of an unusual object for which the child had no label. Six different acoustic forms were created for each word: the citation form; the word with unreleased final consonant; deleted final consonant; deleted initial consonant; vowel replaced with another vowel; and the vowel produced alone. The children's looks to the right or left side of the screen were recorded. In the second experiment, the test was modified to increase the children's overall attention. In both tests, the children looked preferentially at one side of the screen on some of the experimental word forms but not on the control words. They responded preferentially when either one or both consonants were present, and for some words, the correct vowel was critical. In general, the results are consistent with views that children do not perceive words in complete, adult-like forms, but focus only on a few salient features of the adult target. As anticipated, much individual variation was found and research methods to reduce data variability are recommended. (MSE)

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PHONOLOGICAL PERCEPTION OF EARLY WORDS

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Recent theories of phonological acquisition (e.g., Macken & Ferguson, 1982; Schwartz & Leonard, 1982; Waterson, 1981) suggest that children play an active role in the construction of a phonological system - extracting and storing information from adult words heard in the environment. Initially, the child is thought to analyze and store whole words or word shapes on an individual (i.e., word-by-word) basis, and not as a sequence of segments or phonemes. These stored forms need not necessarily include all of the characteristics of the adult form. A child might store a form that differs from the adult's production because of an isolated misperception or as the result of a set of perceptual encoding rules. However, in spite of these recent theoretical views, there is little empirical data concerning the perception of meaningful speech during the early stages of language development (e.g., during the period of the first 50 words). Because of the lack of an adequate methodology for studying meaningful perception at this age, developmental phonologists of all theoretical backgrounds have been limited to speculation about the actual nature of children's perception. Such speculations have relied heavily on inferences from phonetic discrimination abilities or production abilities.

Some theorists (e.g., Stampe, 1973) argue that the child's perception of words is adult-like in accuracy, basing this assumption on infants' phonetic discrimination abilities. Infant speech perception studies have shown that even very young infants are capable of discriminating among most of the sounds in their language. However, all of the studies have used non-meaningful stimuli, such as syllables. There are several reasons to question the relationship between these early discrimination abilities and the later perception of meaningful speech. To perceive meaningful stimuli, a child must not only discriminate among the various sounds, but also relate the stimuli to some stored form that is associated with a particular meaning. The greater demands placed on the child in this type of task might cause him to selectively attend to only some of the information available in the signal. The child may ignore other information in the signal, including phonetic discriminations that he was capable of making as an infant. Furthermore, what the child considers to be relevant may differ from what adults consider relevant.

Other developmental phonologists (e.g., Macken, 1980) have attempted to infer perceptual abilities from children's productions. For example, if a child never produces a contrast in his own speech, it is possible that he does not perceive that contrast. However, there are many documented cases of the so-called "fis" phenomenon, where a child fails to make a distinction in his own production, but rejects an adult's production without the distinction (e.g., Berko &

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Brown, 1960). Such instances indicate that children's perceptual abilities may not be identical with their production abilities in all cases.

Obviously, neither inferring from infant phonetic discrimination nor inferring from children's production represents an acceptable method for specifying the nature of phonological perception in young children. Unfortunately, there is no empircal data on children's phonological perception during the period in which they are acquiring their first 50 words (i.e., from 12 to 24 months of age). The reason for this lack of data is that there is no available methodology for studying meaningful perception in this age group. Studies of meaningful perception have employed minimal word pairs and paradigms in which children are asked to point to or manipulate a picture or an object (see Barton, 1980, for a review). Such tasks have not been very successful with children under two years of age. In addition, the focus of these studies has been on the discrimination of contrasts between segments or phonemes. Other units of contrast, such as whole words or word shapes, have been ignored. Because many of the recent theoretical proposals suggest that early stored representations are based upon these larger units, there is a need for direct investigation of children's perception of such units.

Some of the paradigms that have been used for testing phonetic discrimination and bimodal perception in infants have the potential for testing phonological perception with slightly older children. One is the visual preference procedure originally used for testing infants' knowledge of auditory and visual relationships (e.g., Spelke, 1978, 1981). Although the task was originally created for testing non-meaningful stimuli, the visual preference procedure has been adapted for testing the comprehension of words in one-year-olds by several investigators (Golinkoff et al., 1987; Thomas et al., 1981). These studies have shown that visual preference paradigms can be used with real word stimuli and with one-year-old children.

In a visual preference procedure, two visual events are shown simultaneously, side-by-side, and one auditory stimulus is presented from a central location. Observers judge when the subjects look to the matching event and to the non-matching event. A higher proportion of time looking towards the matching event is considered evidence that the subject detects the auditory-visual relationship.

The purpose of the present investigation was to further adapt the visual preference procedure to assess meaningful phonological perception in one-year-old children. Previous studies with this procedure in this age range had assessed word comprehension, but had not manipulated any phonological variables. The present paper describes two experiments in which we examined children's recognition of several acoustically distorted variations of familiar words.

Experiment I

Method

Figure 1 shows the experimental setting. The children sat in a high chair in a sound-treated booth facing a projection screen. The parent sat either behind them, or beside them facing away from the

screen. Slides were rear-projected through a window from an adjacent room. The children were videotaped as they watched the slides, and observers scored looks to the left or right slide as they viewed the child on the video monitor. The observers were not aware of the lateral position of the slides or of the auditory stimulus presented. Observer responses were fed into a computer to be timed and compared to an answer key.

Figure 1. Experimental setting

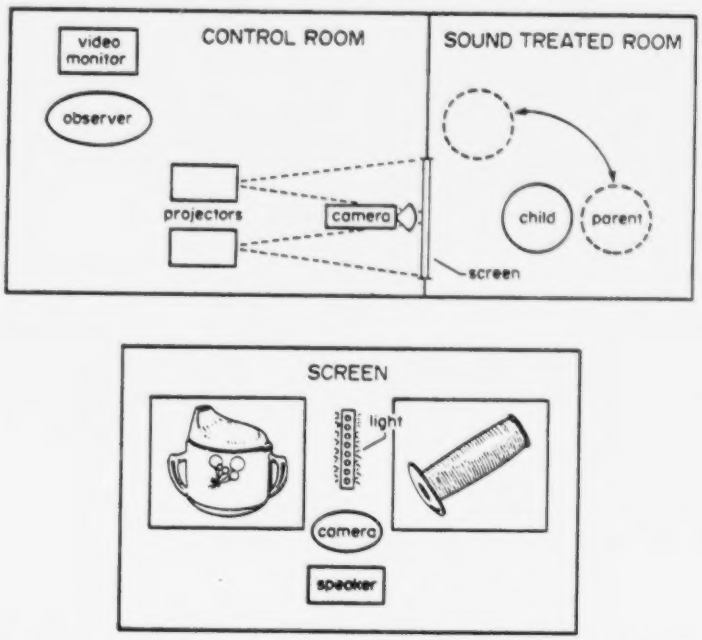

Figure 1 also shows the screen that the children saw. The visual stimuli consisted of color photographic slides of objects representing the experimental words (dogs, books, and cups) and of unusual objects for which they had no label (carrier straps, bicycle grips, and hasps mounted on colored blocks). Several exemplars of each object were used, with slight variation in form and color to help maintain subject attention. In the center of the screen was a strip of red lights used to draw the subjects' attention to midline at the beginning of each trial. The camera and speaker were located in the center of the screen below the slides.

Table 1 shows the auditory stimuli. Three CVC words (dog, book, and cup) were chosen as stimuli because of their common occurrence in the vocabularies of children in this age range, and the ease with which their referent could be represented visually. Six different acoustic forms were created for each word. Form 1 represented the citation form of each word. In Form 2 the final consonant was not released. In Form 3 the final consonant was deleted, and in Form 4 the initial consonant was deleted. In Form 5, the vowel was replaced by another vowel. Form 6 consisted of only the vowel from each word. In addition, one form each of two nonsense words were used as control

stimuli. They did not share any consonants in the same word position as any of the real words, did not contain any of the same vowels, and did not represent error productions of words common in an early vocabulary. The auditory stimuli were created using natural speech that was digitally edited.

Table 1. Phonetic transcriptions of auditory stimuli.

Form	Experimental Words			Control Words	
	dog	book	cup		
1	[dɔg]	[bʊk]	[kʌp]	[gut]	[ob]
2	[dɔgˈ]	[bʊkˈ]	[kʌpˈ]		
3	[dɔ]	[bʊ]	[kʌ]		
4	[ɔg]	[ʊk]	[ʌp]		
5	[dæg]	[bɪk]	[kɛp]		
6	[ɔ]	[ʊ]	[ʌ]		

In the first experiment, 12 children from 15 to 20 months of age served as subjects. They passed a screening test of general development, including language, and a hearing screening. They also passed a comprehension pretest with the experimental words (dog, book, and cup) using the same visual preference paradigm that was then used in the experiment. Thus, these children demonstrated knowledge of the words and a tendency for preferential looking before they were selected as subjects.

The subjects in experiment I sat through six experimental sessions lasting approximately four minutes each. Each session contained 26 or 27 trials. In each trial, one slide was an object representing one of the experimental words, and the other was one of the unfamiliar objects. The left-right position of these was counterbalanced and randomized across each session.

The format of each trial was as follows. First, the slides came on and were viewed in silence for 1 3/4 seconds. Then the midline light flashed for half a second, and after a brief delay the word was heard. Following the end of the word, the subjects were given 3 seconds to look at the slides. It was during these 3 seconds that the observer responses were recorded. Each trial was then followed by 2 seconds of blank screen.

Two measures of preferential looking were used. The first involved duration, and is reported as a proportion of time correct (the proportion of time spent looking at the matching slide out of the total time spent looking at any slide). Suppose, for example, that the child saw a dog and a bicycle grip, and heard [dɔ]. If he recognized that form as the word dog, he would look longer at the slide of the dog. If he did not recognize the form, he would either

look at the bicycle grip or look randomly between the two.

The second was a more general measure of the number of looks toward each slide, and is reported as the proportion of correct looks (the proportion of looks to the matching slide out of the total number of looks). Given the same example, if the child recognized [dɔ] as the word dog, he might look more times to the slide of the dog than to the slide of the bicycle grip.

With both measures, the mean proportion correct was compared to .50, or chance, using a one-tailed *t*-test. We corrected for multiple comparisons by using a stricter criterion of significance, .025.

Results

The results of Experiment I are shown in Table 2. The subjects did look preferentially on some of the forms of the experimental words, but not on the control words. Therefore, they were not simply looking preferentially to the slides of the familiar objects as opposed to unfamiliar objects, regardless of the auditory stimulus. Looking at the proportion of time correct, you will see that the children looked longer at the slide of the dog when they heard [dɔg], [dɔgˈ], [dɔ], or [ɔg], but not when they heard [dæg] or [ɔ]. With the proportion of correct looks, they looked at the dog more times when they heard [dɔgˈ], [dɔ], or [dæg], but not when they heard the other forms. Fewer forms elicited preferential looking with book and cup. It is possible that dog was a more familiar word to these children, and thus they were more tolerant of distorted productions of it. In general, proportion of time correct seemed to be a more sensitive measure than proportion of correct looks.

Looking at the data from Experiment I, a couple of patterns emerge. For example with the word dog, the children seemed to recognize only those forms that contained at least one of the two consonants. With the time measure, the forms recognized also contained the correct vowel. This finding is consistent with theoretical views suggesting that children do not necessarily pay attention to all of the features of the adult production. Looking at all three words, the one form that was recognized in each was the form with the final consonant deleted - [dɔ], [bʊ], and [kʌ]. It is interesting to note that this form is similar to common production patterns for such words in children of this age.

We need to be somewhat cautious in interpreting these group data, given the amount of individual variation found in the different words and the different subjects. In addition, the subjects in Experiment I tired of the task after the first few sessions, and overall the amount of attention they paid to the slides decreased over time. Overall, the proportion of time they spent attending to one or more of the slides averaged 76%.

Experiment II

Method

Because of the problems encountered in maintaining the subjects' attention in Experiment I, a second study was designed using the same stimuli. The task was modified in several ways to increase the

Table 2. Mean proportion of preferential looking.

Word Form	EXPERIMENT I		EXPERIMENT II
	Time Correct	Correct Looks	Time Correct
[dɔg]	.62 *	.56	.58
[dɔgˀ]	.64 *	.60 *	.65 *
[dɔ]	.64 *	.63 *	.56
[ɔg]	.66 *	.55	.68 *
[dæg]	.60	.60 *	.57
[ɔ]	.59	.56	.56
[bʊk]	.60	.48	.45
[bʊkˀ]	.57	.50	.68 *
[bʊ]	.62 *	.49	.53
[ʊk]	.55	.49	.69 *
[bɪk]	.50	.54	.54
[ʊ]	.54	.50	.57
[kʌp]	.60	.49	.51
[kʌpˀ]	.63 *	.57	.56
[kʌ]	.65 *	.60 *	.55
[ʌp]	.49	.55	.61
[kɛp]	.65 *	.62 *	.52
[ʌ]	.60	.50	.52
[gut]	.57	.48	.60
[ob]	.48	.52	.41
* p < .025	$t(11) \geq 2.201$		$t(13) \geq 2.160$

overall attention to the stimuli. First, the number of sessions was reduced to four. Each session contained 23 trials. In addition, the length of each individual trial was shortened. The 1 3/4 second silent viewing period was eliminated. The slides came on and the light flashed almost immediately. The responses were still recorded for 3 seconds after the word ended, but the amount of blank screen time between each trial was shortened to only 1 second.

The 14 subjects in Experiment II were 19 and 20 months of age. They also passed a screening of general development and hearing sensitivity. However, they did not participate in the comprehension pretest using the visual preference procedure. It was felt during Experiment I that sitting through the pretest had contributed to the general loss of interest in the task over time. Instead, in Experiment II parental report of word comprehension was accepted. All of the parents reported that their child both comprehended and

produced the three experimental words. The visual and auditory stimuli were the same as those used in Experiment I. However, distribution of the various slide exemplars over the sessions was different. In Experiment I all 8 exemplars had been used in each of the sessions. In Experiment II, some of the exemplars were reserved for later sessions, so that each session the child saw some new exemplars.

Results

The proportion of attention increased in this second experiment, to an average of 95%. Only the proportion of time correct was analyzed in Experiment II. These results are shown in Table 2. The children again looked preferentially on some of the experimental word forms but not on the control words. Preferential looking was demonstrated on only two words, dog and book. On both words, the children looked longer towards the dog or book when they heard the forms with the final consonant not released. Interestingly, they also looked preferentially when they heard forms without the initial consonant - [ɔg] and [ʊk]. This finding might argue against a linear model of template matching, as the presence of the initial consonant did not seem to be critical for word recognition. Rather, these results lend further support to the notion of the word as the unit in young children's phonologies, and suggest again that these children were not attending to all of the information in the word.

Discussion

A great deal of individual variation was observed in these data. This was not unexpected, given the age of the subjects, and what we know about individual variation in children's production at this age.

One way to reduce this variability might be to control more carefully for word familiarity, linguistic level, and phonological production characteristics. Because of the complex procedures involved in creating the auditory stimuli, it was necessary to preselect stimulus words, and then find children who knew these words. As a result, the subjects did not form a homogeneous group in terms of vocabulary size. There are at least two possible solutions to this probelm. One is to select a homogeneous group of children, in terms of vocabulary size and production characteristics, and to train novel words as stimuli. This would also allow us to create minimal pairs to test specific features, including not only phonemic contrasts but also contrasts in larger units. The other is to select a homogeneous group of subjects and to choose stimuli individually for each subject from their production or comprehension vocabularies. This would require individual data analysis for each subject, perhaps using a signal detection analysis or randomization test.

In conclusion, we view the present study as a first step towards empirically testing hypotheses concerning meaningful phonological perception in one-year-old children. The results are consistent with views that children do not perceive words in complete, adult-like forms. Specifically, the children in both experiments responded preferentially to forms of CVC words when they contained one or both

of the correct consonants, but not when both consonants were missing. In addition, for some of the words, the correct vowel was critical for word recognition.

Although there is not necessarily a direct correspondence between a child's perceived form and stored form, these data would suggest that the information these children had represented about each word involved only a few salient features of the adult target. Future investigations might focus more specifically on one or two of these features, to determine the degree of detail actually required for recognition. With continued modifications to remove task-related and individual subject variability, we feel that the visual preference paradigm has potential for finally acquiring some empirical data on phonological perception in young children.

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